REMARKS

Claims 1, 3-6, 8-11, and 14-24 are pending in the application with claims 1, 14, 15, and 24 being the independent claims. Claims 1, 14, and 15 are amended. Claim 24 is new. Support for these amendments and new claims may be found in the specification and drawings as originally filed.

Background of the Invention

In order to reduce gas consumption in a processing apparatus, a gas circulating system is associated with the processing apparatus to recirculate gas. It is controlled to provide a specific target ratio of the circulating gas flow rate and a primary gas flow rate. Operational tests and measurements show that a high degree of operational stability is obtained at an 80% gas circulation ratio. This 8:2 ratio of circulating gas to primary gas provides economical advantages as well.

The primary gas is normally a mixed gas, containing a number of individual gases. The flow rates of the individual gases constituting the mixed gas, as well as the overall flow rate of the primary gas, are usually adjusted to suit specific processing conditions. However, under normal circumstances, the target ratio of the circulating gas flow rate to the primary gas flow rate remains unchanged even when the primary gas flow rate has been altered. Accordingly, the target ratio does not greatly fluctuate despite changes to the processing conditions.

The structure of the gas supply unit of the invention is used to achieve the target ratio. Therefore, the two types of gases can be supplied with a high degree of consistency at all times.

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Rejections Under 35 U.S.C. § 112

The Examiner rejected claims 1, 3-6, and 8-11 under 35 U.S.C. § 112, second paragraph as being indefinite because claim 1 allegedly recites a broad feature and a narrow feature that falls within the broad feature. Applicants have amended claim 1 to recite, "the target flow rate of the circulating gas being higher than the target flow rate of the primary gas, so that the number of said circulating gas supply holes is greater than the number of said primary gas supply holes." Accordingly, the claim now clearly sets forth the metes and bounds of the protection desired, requiring that the number of circulating gas supply holes be greater than the number of primary gas supply holes. Applicants respectfully request that the Examiner withdraw the rejection of claims 1, 3-6, and 8-11.

Rejections Under 35 U.S.C. § 103

Claims 1, 3-6, 8-11, and 14-23

The Examiner rejected claims 1, 3-6, 8-11, and 14-23 under 35 U.S.C. § 103 as being unpatentable over JP 409251981A to Kurihara *et al.* (Kurihara) in view of U.S. Patent No. 6,086,677 to Umotoy *et al.* (Umotoy) and in view of U.S. Patent No. 5,453,124 to Moslehi *et al.* (Moslehi). Claim 1 is directed to a processing apparatus including a gas supply mechanism that supplies a processing gas into a processing chamber via a plurality of gas supply holes including a plurality of primary gas supply holes and a plurality of circulating gas supply holes. The apparatus includes an evacuating mechanism that evacuates the processing gas from the processing chamber, and a gas circulating mechanism that returns at least a portion of exhaust gas evacuated from the processing chamber to the gas supply mechanism. The gas supply

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mechanism includes a primary gas supply system. The primary gas supply system supplies primary gas supplied from a processing gas source into the processing chamber via the primary gas supply holes. A circulating gas supply system supplies at least a portion of the exhaust gas into the processing chamber via the circulating gas supply holes. The primary gas supply system and the circulating gas supply system are systems independent of each other. Further, the ratio of the number of primary gas supply holes and the number of circulating gas supply holes equals the target ratio of the primary gas flow rate and the circulating gas flow rate. The flow rate of the circulating gas is higher than the flow rate of the primary gas, so that the number of circulating gas supply holes is greater than the number of primary gas supply holes. The hole radius and the hole density of the primary gas supply holes are constant over an entire surface and the hole radius and the hole density of the circulating gas supply holes are constant over the entire surface.

Kurihara teaches a semiconductor manufacturing system that includes a chemical cylinder 111 which supplies process gas to a vacuum tube (sic) 101 through a nozzle. A turbo molecular pump 105 is connected to the vacuum tube 101, and a recycle line 107 extends between the exhaust side of the pump 105 and the vacuum tube 101. *See* Kurihara, paragraph 11. A nozzle, as shown in FIG. 5, includes an equal number of holes for gas flow from a recycle line 107 and gas flow of the process gas supply from the chemical cylinder 111. FIG. 5 shows the holes from the recycle line being located at one side of the nozzle and the holes from the process gas supply being located at the other side of the nozzle.

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Umotoy teaches a dual gas faceplate for a showerhead in a semiconductor wafer processing system having a lower gas distribution plate 148 and an upper gas distribution plate 150. The two plates define distinct passageways for two process gases to enter a processing region 104. *See* Umotoy, column 4, line 65-column 5, line 2. The showerhead includes a portal region 200 having two sets of holes 204 and 206, where each hole has a center-to-center spacing approximately 6.35 mm from a neighboring hole. *See* Umotoy, column 5, lines 31-34. The holes 204 allow passage of the first gas and the holes 206 allow passage of the second gas. *See* Umotoy, column 5, lines 47-51. The holes provide gases to a process region without commingling the gases prior to entering the process region. *See* Umotoy, column 2, lines 39-43; column 2, line 66-column 3, line 1. The hole size, however, may vary across the faceplate surface so that gas flow rates through the holes are correlated with the location of the hole in the faceplate. *See* Umotoy, column 5, lines 38-43.

Moslehi discloses a multi-zone gas injector 12. The injector 12 includes a showerhead plate 18 that includes a plurality of orifices 22 located in a center zone 24. A plurality of orifices 26 are arranged in an annular configuration encircling the center zone 24, and forming a middle zone 28. A third series of orifices 30 are arranged in an annular configuration to encircle the orifices 26. *See* Moslehi, column 3, lines 47-58. Each zone is attached to a flow control for independently controlling the amounts and ratios of gas to each zone. *See* Moslehi, Abstract.

However, none of Kurihara, Umotoy, and Moslehi, alone or in combination, establishes a *prima facie* case of obviousness. To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or

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motivation to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference(s) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488 (Fed. Cir. 1991). *See* MPEP § 2143.

Independent Claims 1 and 14

There is no suggestion or motivation in the art to combine Kurihara, Umotoy, and Moslehi in the manner suggested by the Examiner. The teaching or suggestion to make the claimed combination must be found in the prior art, and not based on the Applicants' disclosure. The Examiner suggests that the motivation to combine the references is to make the gases flow evenly on the substrate with the circulating gas having a higher conductance. *See* Office Action, page 4. The present invention does precisely that. *See* Specification, page 5, lines 4-7, page 13, lines 10-12. However, there is no motivation in the art itself to combine the references to provide the claimed invention.

Umotoy discloses evenly distributed holes whose size may vary across the surface so that flow rates may be higher in some locations and lower in others. *See* Umotoy, column 5, lines 38-43. With nothing more, Umotoy fails to provide any suggestion or motivation for combining its teachings with the teachings of Moslehi. The motivation suggested by the Examiner is not found in the prior art, but is instead found in Applicants' disclosure.

Moslehi discloses a set of orifices in each of three zones having independent flow controls. The mere fact that the gas flow to each zone may be adjusted does not

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provide motivation to combine reference teachings. Also, the mere fact that Moslehi teaches providing gas to different zones at different flow rates does not provide motivation for combining the references. Moslehi fails to provide any suggestion or motivation for combining its teachings with the teachings of Umotoy. Instead, the suggestion to combine reference teachings comes only from the Examiner, and even that suggestion is derived through improper hind-sight reasoning based on Applicants' disclosure. Accordingly, Applicants respectfully request that the Examiner withdraw the rejection, and allow these claims.

For the reasons set forth above, independent claims 1 and 14 are patentable over the combination of references. Applicants respectfully request that the Examiner withdraw the rejection, and allow these claims. Claims 3-6, 8-11, and 16-23 depend from and add additional features to independent claims 1 and 14. Accordingly, these claims are patentable for at least the reasons set forth above. Applicants respectfully request that the Examiner reconsider and withdraw this rejection

Even if the references were properly combinable, the combination of references fails to render claims 1 and 14 unpatentable because the references fail to teach or suggest that "the ratio of the number of said primary gas supply holes and the number of said circulating gas supply holes equals the target ratio of a primary gas flow rate and a circulating gas flow rate, the flow rate for the circulating gas being higher than the flow rate for the primary gas, so that the number of said circulating gas supply holes is greater than the number of said primary gas supply holes," as recited in claims 1 and 14. Both Kurihara and Umotoy teach or suggest only holes with a 1 to 1 ratio. A 1 to 1 ratio would require that the primary gas flow rate and a circulating gas flow rate be

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different out of each set of holes, when the target ratio is not 1 to 1, as is claimed. Further, the system taught in Umotoy is unable to supply a consistent gas supply because as the ratio changes, the flow rates through the hole sets will also change.

The Examiner suggests that Moslehi teaches that the number of holes or the area of holes in a zone of could differ from that of another zone. *See* Office Action, page 4. But merely providing a different number of holes in a zone does not render claims 1 and 14 unpatentable because the claimed feature that the ratio of holes equals the target ratio of the flow rates, and the feature that the flow rate for the circulating gas is higher than the flow rate for the circulating gas is not taught or suggested in any of the cited references, including Moslehi.

Also, Moslehi does not teach or suggest that the ratio of holes in different zones and the target ratio of flow rates through the holes are equal. In Moslehi, if the target ratio of the flow rates were to equal flow rate for each zone, the passage of gas through the orifices out of each zone would still not be equal to the target flow rate ratio because, as shown in the figures, each zone is a different size and includes a different number of orifice holes. Accordingly, the target ratio of flow rates of the zones is not equal to the ratio of the number of holes of each zone, as recited in claims 1 and 14.

Finally, claim 14 recites that "the circulating gas holes are spaced differently than the primary gas supply holes, and surround the primary gas holes." None of the cited references teaches or suggests this feature. Instead, the references show holes with the same spacing, and any circulating holes do not surround the primary holes.

None of Kurihara, Umotoy, and Moslehi, alone or in combination, teaches or suggests all the features of claims 1 and 14. Accordingly, claims 1 and 14 are

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patentable over this combination of references. Applicants respectfully request that the Examiner reconsider and withdraw this rejection.

Claims 3-6, 8-11, and 15-23 depend from and add additional features to independent claims 1 and 14. Accordingly, these claims are patentable for at least the reasons set forth above with regard to claims 1 and 14. Applicants respectfully request that the Examiner reconsider and withdraw this rejection.

Independent Claim 15

Independent claim 15 is also patentable over the cited combination of references. First, for the reasons set forth above, the combination of references cited by the Examiner is improper for lack of motivation to combine. Second, none of the references teaches or suggests all the features of claim 15. Claim 15 recites that "the ratio of the total area of said primary gas supply holes and the total area of said circulating gas supply holes equals the target ratio of a primary gas flow rate and a circulating gas flow rate, the flow rate for the circulating gas being higher than the flow rate for the primary gas, so that the total area of said circulating gas supply holes is greater than the total area of said primary gas supply holes." None of the cited art teaches or suggests such a feature. Umotoy discloses evenly distributed holes whose size may vary across the surface so that flow rates may be higher in some locations and lower in others. *See* Umotoy, column 5, lines 38-43. However, Umotoy does not teach or suggest that the ratio of the total area of the holes equals the ratio of a flow rates for the gases, the flow rate for the circulating gas being higher than the flow rate for the primary gas, so that the total area of the circulating gas supply holes is greater than the total area of the primary gas supply holes, as recited in claim 15.

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Moslehi does not cure this deficiency. Moslehi does not discuss varying the hole size to affect the area or to provide a ratio of area to flow, as recited in claim 15. Likewise, Kurihara provides no teaching or suggestion of the claimed features. Accordingly, claim 15 is patentable over the combination of these references. Applicants respectfully request that the Examiner withdraw the rejection and allow claim 15.

New Claim

New claim 24 is a method claim reciting the features of claim 1. Applicants respectfully request that the Examiner consider new claim 24 and pass it to allowance.

Conclusion

In view of the foregoing amendments and remarks, Applicant respectfully requests the reconsideration of this application and the timely allowance of the pending claims. Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

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Dated: May 21, 2003

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APPENDIX
VERSION WITH MARKINGS TO SHOW CHANGES MADE

AMENDMENTS TO THE CLAIMS

Claim 24 is new.

Claims 1, 14, and 15 are amended as follows:

1. (Four Times Amended) A processing apparatus comprising:

a gas supply mechanism that supplies a processing gas into a processing chamber via a plurality of gas supply holes including a plurality of primary gas supply holes and a plurality of circulating gas supply holes,

an evacuating mechanism that evacuates the processing gas from said processing chamber, and

a gas circulating mechanism that returns at least a portion of exhaust gas evacuated from said processing chamber to said gas supply mechanism,

wherein said gas supply mechanism includes,

a primary gas supply system that supplies primary gas supplied from a processing gas source into said processing chamber via said primary gas supply holes, and

a circulating gas supply system that supplies at least a portion of the exhaust gas into said processing chamber via said circulating gas supply holes with said primary gas supply system and said circulating gas supply system constituted as systems independent of each other, and

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wherein the ratio of the number of said primary gas supply holes and the number of said circulating gas supply holes [is set equal to] equals the target ratio of a primary gas flow rate and a circulating gas flow rate [of a target flow rate for said primary gas and a target flow rate for said circulating gas], the flow rate of the circulating gas being higher than the flow rate of the primary gas, so that the number of said circulating gas supply holes [being] is greater than the number of said primary gas supply holes, and

wherein the hole radius and the hole density of said primary gas supply holes are constant over an entire surface and the hole radius and the hole density of said circulating gas supply holes are constant over the entire surface.

14. (Amended) A processing apparatus comprising:

a gas supply mechanism that supplies a processing gas into a processing chamber via a plurality of gas supply holes including a plurality of primary gas supply holes and a plurality of circulating gas supply holes;

an evacuating mechanism that evacuates the processing gas from said processing chamber; and

a gas circulating mechanism that returns at least a portion of exhaust gas evacuated from said processing chamber to said gas supply mechanism,

wherein said gas supply mechanism includes,

a primary gas supply system that supplies primary gas supplied from a processing gas source into said processing chamber via said primary gas supply holes, and

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a circulating gas supply system that supplies at least a portion of the exhaust gas into said processing chamber via said circulating gas supply holes with said primary gas supply system and said circulating gas supply system constituted as systems independent of each other, and

wherein the ratio of the number of said primary gas supply holes and the number of said circulating gas supply holes equals the target ratio of a primary gas flow rate and a circulating gas flow rate, [wherein] the flow rate for the circulating gas being higher than the flow rate for the primary gas, so that the number of said circulating gas supply holes is greater than the number of said primary gas supply holes,

and the circulating gas holes are spaced differently than the primary gas supply holes, and surround the primary gas holes.

15. (Twice Amended) A processing apparatus comprising:

a gas supply mechanism that supplies a processing gas into a processing chamber though primary gas supply holes;

an evacuating mechanism that evacuates the processing gas from said processing chamber, and

a gas circulating mechanism that returns at least a portion of exhaust gas evacuated from said processing chamber to said [gas supply mechanism] processing chamber through circulating gas supply holes,

wherein said gas supply mechanism includes,

a primary gas supply system that supplies primary gas supplied from a processing gas source into said processing chamber, and

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a circulating gas supply system that supplies at least a portion of the exhaust gas into said processing chamber with said primary gas supply system and said circulating gas supply system constituted as systems independent of each other, and

wherein the ratio of the total area of said primary gas supply holes and the total area of said circulating gas supply holes equals the target ratio of a primary gas flow rate and a circulating gas flow rate, the flow rate for the circulating gas being higher than the flow rate for the primary gas, so that the total area of said circulating gas supply holes is greater than the total area of said primary gas supply holes [wherein the total hole area of the primary gas supply holes is less than the total hole area of the circulating gas supply holes].

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